

CDPH&E. Note that all the data are in micro-curies. There is no evidence of any significant release from this source.

The Site did bury uranium in drums in the early years. In recent years the drums in the T-1 trench have been dug up, removed from the Site, and the area surrounding the location remediated. There may be other buried uranium in the early dump sites at the Site. These dump sites have been identified and will be addressed in the Rocky Flats Closure Project. Currently, there is a separate action to sample the ground water at a number of locations for U-236. The results of this sampling will be of interest to this evaluation as U-236, if found, could only be from recycle uranium. Depleted uranium lathe coolant and other DU contaminated organic liquids were burned in open pits in the 60's and 70's. Estimates of the release during burning were based on environmental data taken during the burn operations and are contained in the CDPH&E report.

4.4 Data Sources and Confidence Level

There is a confidence on the mass balance data for both the highly enriched and depleted uranium because of the extensive data search through all the Site receipt and shipping records. Mass balance data on shipments and receipts of depleted uranium between the Site and Fernald and Paducah, the largest suppliers, have been compared. The summaries of the data comparison are listed in Tables 3 and 4. The depleted uranium data are in close agreement considering the time span and amount of material shipped. No comparison of the highly enriched uranium mass balance data has been conducted, but it is expected these data are very accurate because of the tracking system used between the sites that required immediate resolution of any shipper receiver differences.

The evaluation of processes to determine any that could result in accumulation or release was based on the collective memories of a number of "old-time" employees. While not as specific as the mass balance activity, there is confidence that these employees had an understanding of the task to evaluate prior processing history.

5.0 HEALTH PHYSICS PROTECTION FEATURES FOR URANIUM WORK AT ROCKY FLATS¹⁴

During the hot startup of the uranium facilities, and during the entire period of operations in the various uranium buildings at Rocky Flats, the following practices, measures, and protective procedures for uranium workers were followed by DOE and the operating contractors:

- Physicals were accomplished for all personnel prior to date of hire by the Site's medical staff, and periodically thereafter.
- Company clothing was furnished and laundered by the operating contractor. The protective clothing included: coveralls, smocks, underwear, socks, caps, gloves of various types, and shoe covers, as required. The clothing was monitored for radioactivity and laundered on a daily basis.

- Routine monitoring of personnel and their clothing for radioactivity was accomplished on a daily basis by health physics monitors or by self-monitoring. Monitoring was required prior to lunch, breaks, and leaving the facility. Full compliance with monitoring was not assured until the late 80's
- Safety shoes were furnished to all personnel as required in the production and regular work areas. Separate safety shoes were required for the contaminated areas, and separate lockers maintained to keep them separated from the cold shoes.
- Lockers were furnished to all personnel for clothes change and separation of personnel and company clothing. Showers were required prior to leaving the facility at the end of the shift.
- Cafeterias were furnished in each building to provide for lunch and break areas, with separate storage areas for lunch boxes. Eating was not allowed in the process areas. However, there are Site personnel who recall that in the early days some workers would eat and smoke at their machines. The cafeterias were monitored daily to provide for contamination control. Break rooms may not have been as controlled.
- Urine bioassay sampling was required and performed on all personnel on a periodic basis. The sampling frequency depended on the various areas, and the possibility of exposure and/or incidents. Bioassay data for the period from 1953 to 1988 are included in Table 8.
- Respiratory protection was provided and required whenever airborne radioactivity was known or suspected. The most common respiratory protection in the uranium areas was either Wilson or MSA Comfo-type half-mask respirators. There were a few occasions where canister-type respiratory equipment or supplied air-type operations were used when required by Health Physics and/or by Industrial Hygiene. Full compliance with required respiratory protection was not always achieved, especially in the early years.
- Industrial Hygiene personnel performed routine sampling and made recommendations in the areas of handling various chemicals and toxic materials in the work areas. (This included sampling for beryllium, asbestos, solvents, toxic materials/fumes, etc.)
- Health Physics surveys for alpha, beta and gamma radiation/contamination were taken on a continuous routine basis. These surveys included the use of instruments such as Pee-Wees, 2610As, Cutie Pies, Junos, Combos, PCs, PC-2s, etc. The surveys were taken as needed to control the alpha contamination of both surface and airborne, and the beta/gamma to control exposure to personnel working directly with uranium.
- Air sampling was accomplished on a daily basis to monitor the following: room air in the buildings, special breathing zone sampling, special operations/equipment, high volume and portable air sampling, effluent air sampling and Site survey-type air sampling, on and off site. All main building exhaust stacks were monitored on a continuous (24 hr./day) basis, and hundreds of room air samples were changed daily and checked for uranium using 70dpm/cubic meter as 100% of the RCG. (Note: 25%

of the RCG on the general room samples was used as an action level requiring corrective action.) The stack effluent samples were exchanged weekly, and corrective action was taken if any adverse trends were noted.

- HVAC in the work areas was maintained, monitored, and corrected as needed. Air flows and air change rates in the rooms and on equipment to contain and control the airborne contamination was closely controlled. This was not only monitored closely by use of magnehelic-type equipment and linear air flow equipment, but also by continuously checking the differential pressure measured across the filters, and the cleaning and changing of same. One of the main ways of controlling the contamination, and to provide adequate protection for the workers, was to control the air flow and keep the contamination away from the workers. Proper air flow helped to reduce the spread of contamination and minimize the possibility of inhalation of radioactive particles and toxic materials to the uranium workers.
- Dosimetry – Measurements with dosimetry badges has been accomplished on a routine basis since the start of operations at Rocky Flats. Starting in 1952 through 1956, metal type film badges were used for both wrist and body exposures. The film was processed at Los Alamos. Results of the film badges in the uranium area date back to the start of operations in 1953. During the years 1956 through 1958 the film badges were changed to a plastic type dosimeter and the work was contracted out to an offsite contractor. In 1958 a dosimetry laboratory was set up in building 123 and all records maintained by the operating contractor. In 1969 - 1970, the film badge program completely converted over to the TLD badge which was designed for neutrons and gammas using seven crystals, and provided the capability of measuring betas, soft x-rays, gamma rays and fast neutrons, as low as 1 mrem gamma and 10 mrem neutrons. Table 9 is a listing of the number of persons with dosimetry badges for each year. The data are only available for the prime contractor personnel prior to 1977.

Studies were also conducted and data collected in the areas of toxicity effects of uranium, body counting, wound counting, and various effects of ionizing radiation on the human body through autopsy studies.

It should be noted that all Health Physics samples, (including air, soil, vegetation, water, smears, etc.) that were analyzed for radioactivity at Rocky Flats, were mainly checked for gross alpha in the uranium areas. In general, the data do not indicate or characterize that the uranium streams at Rocky Flats contained transuranics or fission products. Very little specific radionuclide data that was available. The health physics sampling program did not sample for transuranics in uranium that was processed at Rocky Flats.

Table 8.

The Number and Type of Bioassays and Individuals by Year.

Year	Number of samples-----						# Individuals with Bioassay		
	G	D	U	U-Iso	P	PU239	U+Pu	Pu	D or G or U
1953	453		309		1	285	4	84	318
1954	833	45	752		2	463	17	103	425
1955	381	155	1284		3	513	25	137	503
1956	460	170	1521		2	583	34	171	601
1957	504	246	1956		3	1238	57	305	712
1958	554	177	2309		10	1239	75	315	781
1959	646	147	2891		8	1249	74	359	849
1960	467	154	3614		5	1161	85	369	879
1961	800	181	2773		7	1282	110	468	1054
1962	723	139	1731		4	1853	112	619	976
1963	755	151	2070		18	3161	155	809	1037
1964	705	53	1916		124	3627	185	886	1058
1965	612	21	1573		67	4023	189	1047	1039
1966	539		834		70	3741	117	1066	995
1967	538		694		69	3584	108	1069	1012
1968	541		731		69	3378	130	1098	1048
1969	176		454		63	3991	115	1525	505
1970	296		810		48	3675	256	1579	866
1971	662		618		67	6034	117	1645	1022
1972	672		730		65	4501	96	1465	1218
1973	685		723		43	4234	87	1363	1049
1974	322		1093		55	4640	456	1729	1184
1975			1701		97	5055	814	2028	1426
1976			488		234	5418	191	2533	208
1977			247		197	4660	170	2626	172
1978	1		395		199	5167	225	2874	227
1979			353		128	5095	241	3216	241
1980	1		276		184	5436	201	3603	202
1981			358		195	5812	275	4023	275
1982			1415		274	7012	869	4872	877
1983			1674		432	7260	960	5179	966
1984			1673		905	8119	961	5828	970
1985			1614	1	977	7957	880	6041	910
1986			1177	1065	4268	6910	723	3823	740
1987			549	533	2932	3851	436	2523	446
1988			392	296	3871	3531	245	2892	322

Notes: G Gross Alpha

U Total Uranium (U-234+U-238 in disintegrations per minute)

U-iso Designation for isotopic uranium (U-234, U-235, and U-238)

P Pu-239 (by some method)

Pu-239 Pu-239/240 by alpha spectroscopy

Table 9

Number of persons with external dosimetry badges for each year.

Year	Prime Contractor	Sub-contractors & DOE	Total
1953	262		
1954	341		
1955	512		
1956	719		
1957	868		
1958	1046		
1959	1090		
1960	1362		
1961	1602		
1962	2147		
1963	1798		
1964	3005		
1965	3018		
1966	3175		
1967	3221		
1968	3115		
1969	3850		
1970	3811		
1971	3959		
1972	3777		
1973	3514		
1974	3151		
1975	2956		
1976	2908		
1977	3114	1685	4799
1978	3464	2348	5812
1979	3511	1677	5188
1980	3879	775	4654
1981	4345	614	4959
1982	5138	590	5728
1983	5622	915	6537
1984	6046	1674	7720
1985	6257	1447	7704
1986	5747	1265	7012
1987	4945	1465	6410
1988	5093	1712	6805

6.0 References

List of References for RU project

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2. Robert E. Tiller ltr, RET-024-99, to David C. Lowe, *Plan to Address Recycled Uranium Materials*, November 23, 1999.
3. Steven L Scott ltr, 00920, to Len A. Martinez, *Recycle Uranium Project*, December 20, 1999.
4. L. A. Martinez ltr, LAM-557-99, to Steven L Scott, *Cost, Scope, and Schedule Impact of Recycled Uranium Project*, December 29, 1999.
5. Purchase Requisition number P451860 with SAIC to perform classified record search and provide summary data for Eu and DU. December 28, 1999.
6. Purchase Requisition number P451861 with LATA to perform Recycle Uranium Process Evaluation. December 28, 1999.
7. LATA report on the *Flow of Recycled Uranium at the Rocky Flats Plant 1952 – 1989*, March 1, 2000
8. Report on *Air Pollution Emission Notice for Building 881*, May 9, 1991. Note that revision 2 was issued on December 3, 1993
9. Report on *Air Pollution Emission Notice for Buildings 879/883*, March 1, 1991.
10. Report on *Air Pollution Emission Notice for Buildings 444, 445, 450, and 455*, April 15, 1991.
11. History notes provided by William W. Leslie and Lewis DiGiallonardo as part of prior employees contracted to review process history.
12. Report on *Air Pollution Emission Notice for Building 447, 448, 451*, November 12, 1990.
13. Report on *Air Pollution Emission Notice for Buildings 865, 887, 868*, March 12, 1991, Note that a revision 1 was issued on December 4, 1992.
14. Appendix A, *Health Physics Protection Features for Uranium Work at Rocky Flats*, of the LATA report on the *Flow of Recycled Uranium at the Rocky Flats Plant 1952-1989*, March 1, 2000.
15. *Estimating Historical Emissions From Rocky Flats 1952-1989*, March 1994, Prepared by ChemRisk for the Colorado Department of Public Health and Environment.